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MCC/Shuttle Test Plan Volume 1 Philosophy and Guidelines

Contract NAS 9-15014

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PREPARED FOR
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SECTION 1

INTRODUCTION

1.1 PURPOSE

The purpose of the Mission Control Center (MCC)/Shuttle Test Plan is to define the entire MCC/Shuttle testing activity from development through operations to a level of detail which will support the National Aeronautics and Space Administration (NASA) and contractor management in the following areas:

- A. Test Management. Provide the definition and guidelines that will ensure that all systems are tested to the proper level throughout the development and operations phases. This test plan will provide the planning tool to ensure that the test program is conducted in a consistent manner.
- B. Test Tool Development. Provide the planning and definition at an early date to ensure that the test tools being developed will support the required tests, that redundant tools are not being developed by the different contractors, and that commonality between tests through various stages of the development and operations phases is maximized to minimize test tool costs.
- C. Resource and Schedule Planning. Provide a projection of required resources and schedules which lead to a feasible MCC/Shuttle test program.

1.2 SCOPE

The MCC/Shuttle Test Plan governs all testing, including factory testing, for both the development and operations phases. Volume I specifies the levels of testing required and their interrelationships.

1.3 ORGANIZATION

The MCC/Shuttle Test Plan is composed of six volumes:

- Volume I, Philosophy and Guidelines
- Volume II, Development Testing, Aeronutronic Ford Corporation
- Volume III, Development Testing, International Business Machines Corporation (IBM)
- Volume IV, Software Reconfiguration Testing
- Volume V, Validation Testing
- Volume VI, Maintenance Testing.

The purpose and content of each of these volumes is addressed in this volume. Appendix A defines acronyms used throughout this test plan. Appendix B contains definitions of terms applicable to Volume I.

1.4 APPLICABLE DOCUMENTS

- JSC-10013A (DRL 7), Mission Control Center (MCC) System Specification for the Shuttle Orbital Flight Test (OFT) Timeframe
- JSC-10106 (DRL 27), Mission Control Center Operational Configuration Document
- JSC-10099 (DRL 44), Mission Control Center Shuttle Maintenance Plan
- JSC-10105 (DRL 50), M&O Standard Operating Procedure
- JSC-10102 (DRL 47), M&O Operations Plan
- JSC-10081 (DRL 11), Interface Definition Document

- PHO-TR388, PHO Quality/Reliability Plan
- SISO-EX140, System Engineering Standard
- SISO Standards (Volume III)
- JSC-11026, Project Implementation Plan
- JSC-11024, GBSS Test Plan
- JSC-10952, GBSS Management Plan
- JSC-11044, QA Plan
- JSC-10972, QA Procedures
- JSC-11400, Programmer's Guide
- DRL 4, SDPC Test Plan.

SECTION 2

TESTING PHILOSOPHY

2.1 PHILOSOPHY

The basic philosophy for the MCC/Shuttle testing is to establish an integrated test program for all system and subsystem level testing required during the MCC/Shuttle timeframe. The goal of this program is to provide effective and timely testing to demonstrate compliance to hardware/software specifications and mission support requirements. MCC/Shuttle testing consists of two phases:

- Development Testing Phase. Includes predelivery testing, onsite hardware/software certification, and integration testing
- Operational Testing Phase. Includes reconfiguration testing, validation testing, and maintenance testing.

Detailed descriptions of these tests and test phases are provided in sections 3 and 4.

The following groundrules and guidelines will be adhered to throughout the development of the test plan and testing of the MCC Shuttle System.

- A. Hardware. Qualification testing of hardware includes certification of all interfaces in addition to certification of all required functions. Interfaces are tested as a part of these qualification tests (QT's).
- B. Computer Systems (Hardware and Operating Systems). Acceptance testing includes all interfaces and drives end items through the operating systems access methods.
- C. Applications Programs. Applications programs interface with logical end items as a part of their test plans. An example is the Shuttle Data Processing Complex (SDPC) driving the Network Output Multiplexer (NOM) as a part of development testing.

- D. String Testing. Minimum string buildup is planned based upon the preceding guidelines. String tests are related to major functions (i.e., telemetry data flow) and will essentially be a data flow test with predefined data sources. The primary objectives are to assemble large elements of the MCC into a system level flow and exercise specific functions which were not thoroughly checked during development testing.
- E. Validation Testing. This test phase is primarily for operations familiarization and confidence. Minimum internal validation testing should be planned. Advantage should be taken of other testing activities going on within the MCC to assure that minimum system time is required for this activity.
- F. External Validation. External validation is essentially the classical approach but includes an increased emphasis on integration of the mission simulations into the MCC.

2.2 APPROACH

To meet the guidelines and goals established, a test plan for each of the applicable test disciplines will be developed which specifies:

- Guidelines
- Objectives
- Procedures
- Documentation requirements
- Identification of tests to be performed
- Test tools required
- Responsibilities
- Brief description of each test.

The MCC/Shuttle Test Plan provides the baseline from which the detail test design and test efforts will be accomplished. The philosophy, scope, and content of Volumes II through VI are defined in this document.

SECTION 3

DEVELOPMENT TESTING

3.1 PHILOSOPHY

Development testing encompasses all testing performed during the MCC/Shuttle implementation. This includes predelivery testing, onsite hardware/software certification or recertification testing, and onsite integration testing. Figure 1 illustrates the development testing process.

3.1.1 Predelivery Testing. Predelivery testing includes those tests that are performed at the contractor facility prior to installation onsite. The testing that is performed includes:

- Space Information Systems Operation (SISO), hardware acceptance tests (AT's)
- SISO software development testing
- IBM/SDPC software operating system development and predelivery testing
- IBM/SDPC hardware predelivery testing.

Software tests may be performed at the factory or onsite depending on computer availability.

3.1.2 Certification Testing. Hardware/software certification testing includes those tests that are performed in an operational environment onsite to certify and sell off to NASA the deliverable hardware/software components. The testing that is performed includes:

- SISO, hardware QT's
- SISO, hardware modification requalification tests (RT's)
- SISO, software QT

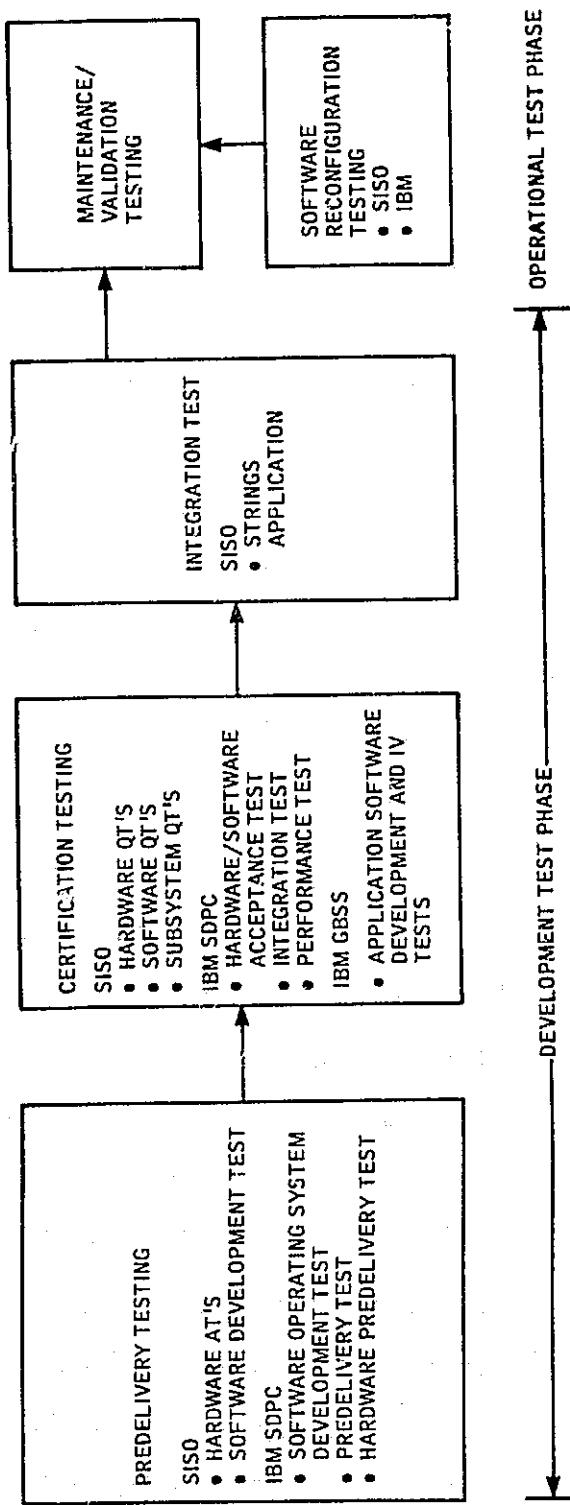


Figure 1 MCC Test Flow Diagram

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- SISO, subsystem QT
- IBM/SDPC, hardware/operating system software onsite AT
- IBM/SDPC, subsystem integration testing
- IBM/SDPC, performance testing
- IBM/Ground-Based Space System (GBSS) application software development testing
- IBM/GBSS, software independent verification testing.

3.1.3 Integration Testing. Integration testing includes those tests that are performed to verify end-to-end application of all MCC/Shuttle hardware/software elements. The primary objective is to assemble large elements of the MCC into application strings such as telemetry and command and verify that they meet operational requirements.

3.1.4 Recertification Testing. The philosophy governing recertification testing is currently being developed and will be included at a later date.

3.1.5 Test Responsibility. Predelivery testing and onsite hardware/software certification testing is the responsibility of the system manager of SISO and IBM responsible for designing and implementing the hardware and/or software. These tests include the testing of the particular deliverable hardware and its immediate interfaces. Integration testing is the responsibility of the Test and Checkout Section of SISO Engineering Integration Department.

3.2 APPROACH

Development testing covers all phases of testing starting with predelivery and culminating with the application string tests. A test plan is required to satisfy MCC/Shuttle development test goals and ensure an orderly process of specification-oriented testing.

The Development Test Plan is contained in two volumes. Volume II is the responsibility of Test and Checkout Section of SISO, supported by the Equipment Engineering Department, the Computer Systems Department, and the Software Systems Department. Volume II addresses all subsystem and systems integration tests. The predelivery and certification of the SDPC subsystem is contained in Volume III, and is the responsibility of IBM Corporation.

3.2.1 Scope. The scope of the Development Test Plan includes plans for each hardware/software subsystem plus all integration testing required to ensure that all requirements of performance specifications are satisfied.

3.2.2 Contents. The Development Test Plan (Volumes II and III) contains at a minimum the following information:

- Detail test philosophy and guidelines
- Documentation requirements; discrepancy reports (DR's), test procedures, test reports, etc.
- Test sequence
- Identification of each test or logical groups of tests to be performed.

Each test identified is then addressed with the following information:

- Test number
- Test title

- Test objective
- Test tools required
- Test configuration (simple block diagram)
- Test dependencies (identify prerequisites for the test such as hardware/software availability and completion of test X or Y)
- Brief description of each test
- Test data scoring method (printer output, visual readout, etc.)
- Support requirements (NASA, SISO M&O and Operations Support, IBM, etc.).

SECTION 4

OPERATIONAL TESTING

4.1 PHILOSOPHY

Operational testing is performed to demonstrate the operational readiness of the MCC to support specified missions. These tests include software reconfiguration, validation, and maintenance.

4.2 SOFTWARE RECONFIGURATION TESTING

Software reconfiguration tests are designed to certify that reconfigurable software tables are configured to appropriate user requirements. Examples of these tests are Telemetry Preprocessor Computer (TPC) tables that define telemetry downlink formats, Institutional Data Systems Division (IDSD) computer-compatible tape (CCT), analog event drivers (AED) output buffers, SDPC output buffers, etc.

4.2.1 Approach. Prior to using the application software for validation testing, it is necessary to verify that software tables have been configured to requirements. These tests are performed on an as necessary basis dependent on the number/degree of changes to the software tables required to support mission operations. The test plan necessary to satisfy these goals is the responsibility of the Test and Checkout Section of SISO with support of the Independent Verification Group of IBM.

4.2.2 Scope. The Software Reconfiguration Test Plan (Volume IV) includes plans for testing all reconfigurable tables for both the TPC and SDPC software.

4.2.3 Content. The Software Reconfiguration Test Plan contains the following minimum information:

- Detail test philosophy and guidelines
- Procedural and documentation requirements

- Test sequence
- Identification of types of tests to be performed.

Each type identified is addressed with the following information:

- Test number
- Test title
- Test objective
- Test tools required
- Test configuration
- Test dependencies
- Brief description of each test type
- Test data scoring method (printer output, visual readout, etc.)
- Support requirements (NASA, SISO, IBM).

4.3 VALIDATION TESTING

Validation testing includes verifying the operational capability of the MCC internal system, the MCC/Simulation interface, and the MCC/Spacecraft Tracking and Data Network (STDN) systems interfaces. These tests also verify that configurations and procedures satisfy user requirements in a mission specific atmosphere from the remote site to the user end instrument. Operational validation testing is accomplished as follows:

- A. Internal validation tests are performed to test internal functions, and provide operations familiarization and confidence.
- B. MCC/Shuttle Mission Simulator (SMS) validation tests are accomplished utilizing the SMS and simulation computers. All defined mission configurations are tested. This demonstrates the ability to support premission simulated flights and establish the readiness of the MCC systems to support external validation testing.
- C. External validation provides the testing of MCC systems with external systems at White Sands (WHS)/Tracking Data Relay Satellite System (TDRSS), Western Test Range (WTR), John F. Kennedy Space Center (KSC), Goddard Space Flight Center (GSFC), the Ground Spacecraft Tracking and Data Network (GSTDN) stations, landing sites, and remote Payload Operations Centers (POC's). In application, these interfaces are proven incrementally with the major task being the data acquisition, recovery, and processing involving the GSTDN and the MCC interface.

The overall configurations for MCC/Shuttle requires extensive testing and verification subsequent to respective deliveries. After initial validation, only abbreviated tests are required for flights which follow.

4.3.1 Approach. Validation tests are performed in an operational configuration to demonstrate the operational readiness of the complete system for a specified mission. The test plan is generated to satisfy the MCC/Shuttle validation test goals. The Validation Test Plan (Volume V) is the responsibility of the SISO Operations Support Department.

4.3.2 Scope. Volume V addresses the testing following integration tests that are performed to assure MCC/Shuttle readiness for specified mission configurations.

4.3.3 Content. The Validation Test Plan contains the following minimum information:

- Detail test philosophy and guidelines
- Documentation requirements (DR's, test procedures, test reports, etc.)
- Test sequence
- Identification of each test to be performed.

Each test identified is then addressed with the following information:

- Test number
- Test title
- Test objective
- Test tools required
- Test configurations (simple block diagram)
- Test dependencies (identify prerequisites for each test such as hardware/software availability and completion of test X and Y)
- Brief description of each test

- Test data scoring method (printer output, visual readout, etc.)
- Support requirements (NASA, SISO, IBM).

4.4 MAINTENANCE TESTING

The maintenance testing ensures that the MCC/Shuttle is in a state of operational readiness to support scheduled user requirements. This is accomplished by implementation of a preventive and corrective maintenance program that ensures equipment availability for operational support. The maintenance program is followed with internal M&O validation tests to verify that the MCC/Shuttle is configured to the current released version of JSC-10106, *Mission Control Center Operational Configuration Document*. These tests also verify that each unit, subsystem, and system is in a state of operational readiness.

4.4.1 Approach. Maintenance testing consists of the maintenance program and maintenance validation testing. These activities are performed by the SISO M&O Department.

- A. **Maintenance Program.** The maintenance program is established by JSC-10099, *Mission Control Center Shuttle Maintenance Plan*. The Maintenance Plan identifies equipment to be maintained, establishes a preventive and corrective maintenance program, provides levels of maintenance coverage, and defines reporting procedures. The plan also establishes standard maintenance procedures outlining policy and guidelines for all maintenance activities.
- B. **Maintenance Validation Testing.** Maintenance validation testing performed by M&O personnel is directed by JSC-10105, *M&O Standard Operating Procedure*, established by JSC-10102, *M&O Operations Plan*. The validation test procedures are developed by M&O and compiled into the MCC Validation and Test Manual, Volume II. The internal M&O Validation tests are conducted in accordance with standard operating guidelines, MCC reconfiguration schedules, and support count sequences directing specific validation tests.

4.4.2 Scope. Volume VI addresses maintenance activities and validation tests performed by M&O in verifying the operational readiness of the MCC/Shuttle to support scheduled users.

4.4.3 Contents. The Maintenance Test Plan identifies preventive maintenance instructions and validation tests and includes the following information:

A. Preventive Maintenance Instruction (PMI) Format

- PMI identification
- Interval of occurrence
- Equipment affected
- Manpower requirements
- Time for completion
- Tools and test equipment required
- Cleaning and inspection instructions
- Functional test instruction.

B. Maintenance Validation Test Format

- Validation test number
- Test title
- Test description
- Scheduling requirements
- Equipment/equipment groups to be tested
- Support equipment and software requirements

- Supporting documentation
- Test data/test report disposition
- Test procedure.

APPENDIX A
ACRONYMS

APPENDIX A

ACRONYMS

AT	Acceptance Test
ATP	Acceptance Test Procedure
BITE	Built-in Test Equipment
DR	Discrepancy Report
DRL	Data Requirement List
GBSS	Ground-Based Space System
GSFC	Goddard Space Flight Center
GSTDN	Ground Spacecraft Tracking and Data Network
IBM	International Business Machines Corporation
IV	Independent Verification
KSC	John F. Kennedy Space Center
MCC	Mission Control Center
NASA	National Aeronautics and Space Administration
NOM	Network Output Multiplexer
OFT	Orbital Test Flight
PMI	Preventive Maintenance Instruction
POC	Payload Operations Centers
QT	Qualification Test
QTP	Qualification Test Procedure
RT	Requalification Test
SDPC	Shuttle Data Processing Complex
SISO	Space Information Systems Operation
SMS	Shuttle Mission Simulator
STDN	Spacecraft Tracking and Data Network

ACRONYMS (CONT'D)

TDRSS Tracking Data Relay Satellite
TPC Telemetry Preprocessor Computer
TPS Test Preparation Sheet
WHS White Sands
WTR Western Test Range

APPENDIX B
DEFINITION OF TERMS

APPENDIX B
DEFINITION OF TERMS

B.1 Development Testing Phase. The development testing phase of software or hardware testing is performed during MCC/Shuttle development beginning with factory testing of discrete hardware/software modules, progressing through specification-oriented testing, e.g., AT's, QT's, RT's, and ending with the final MCC/Shuttle integration test.

B.2 Software Development Test (SISO). Development testing encompasses all testing performed during an application's development phase. Beginning with the testing of the application control type programs, the procedure follows requirements-oriented testing of each function before and after it is incorporated into the current version of the subsystem.

B.3 Software Development Test (IBM). Development testing encompasses all testing performed during an application's development phase. Beginning with the testing of the application control type programs, the procedure follows requirements-oriented testing of each function before and after it is incorporated into the current version of the subsystem. This procedure continues until all elements of the application software are tested together, then it is delivered to the Independent Verification (IV) group as the final system release.

B.4 Software Acceptance Test (SISO)

A. Purpose. The AT is comprised of tests which verify a software entity has been constructed and implemented in accordance with applicable design specifications. A software entity may be a unit (one program), a module or subsystem (a collection of programs), or a complete software system (all programs in all modules). The AT demonstrates that all elements of the software satisfy the performance criteria as specified by an approved AT procedure. An AT is used with vendor supplied software, software developed at other than the using facility prior to

shipment, and software which cannot be tested in its operational environment due to factors such as phased delivery schedule.

- B. Test Procedure. An AT procedure specifies the inspections, tests, and criteria to ensure that the design requirements for the configuration change or product to be delivered have been fulfilled. The criteria should consist of acceptable test results and include measurement and tolerance values. An AT procedure may be prepared for a single equipment component/computer program item, a subsystem, or a system.

B.5 Hardware Acceptance Test (SISO)

- A. Purpose. Hardware acceptance testing certifies the equipment has been manufactured according to applicable documents and the equipment meets major performance requirements as per applicable specifications. Successful completion of the AT and associated signatures constitutes authorization to ship elements to the designated location.
- B. Scope. Hardware acceptance testing is normally conducted upon completion of manufacturing and assembly of the hardware and prior to site delivery. The AT is performed at the manufacturing facility on a hardware element that is generally defined as a module, unit, subsystem component, or subsystem. The AT demonstrates that all elements of the hardware satisfy:
1. Manufacturing and assembly standards in accordance with applicable engineering documentation and standards:
 - QA inspection of workmanship of each manufactured item and of related documentation
 - Engineering verification that the manufactured item is in accordance with applicable documentation.
 2. Functional performance specifications to the extent of the reasonable testing capabilities available in the

manufacturing facility. This testing should include the following:

- Verification of internal functions
- Verification of data throughput
- Verification of interface control logic levels and timing including interface connector pin assignments
- Power requirements
- Verification that design implementation is in accordance with applicable specifications.

C. Test Procedure. The AT is conducted according to an approved acceptance test procedure (ATP). The ATP contains, as a minimum, the following (reference SISO Standards, Volume III, Part 5.1):

1. Identification of the item to be tested.
2. Test objectives.
3. Specification of required test resources (test equipment/software) and calibration reference.
4. Identification of testing tools/methods such as:
 - Built-in test equipment (BITE)
 - Test software (when the element has a computer interface)
 - Other test equipment to simulate an interface.
5. Step-by-step test procedures including initial setup.
6. Pass or fail criteria for the test.

7. Specified operational tolerances.
8. Data sheets that record specific values.
9. Signoff forms.

ATP's are type I documentation. The ATP is approved by the applicable SISO engineering department, Quality Assurance Department, and the Program Management Office, as specified in the SISO Standards (Volume III, part 5.4). The ATP is submitted to NASA for review at least 30 days prior to the scheduled AT.

B.6 Predelivery Test (IBM). Predelivery testing is that testing to be conducted at the IBM facility in Nassau Bay on SDP2 to demonstrate the capabilities of each hardware element type, and the capabilities of the operating systems software, and support software.

B.7 Software Qualification Test (SISO)

A. Purpose. A QT verifies the functional capability of new equipment computer programs following onsite development or installation. The test consists of a series of tests that combine the various elements of a software system into a complete operational entity and verifies performance against established requirements as delineated in the design specification. Successful completion of the QT constitutes delivery and acceptance of the software product by the customer.

B. Test Procedure. The QT is conducted according to an approved qualification test procedure (QTP). The QTP provides detailed documentation of all testing required to demonstrate the software is in compliance with all applicable specification requirements. The procedures will contain, as a minimum, the following:

- Identification of system element to be tested
- Test objective

- Resources required for the test
- Step-by-step procedure for accomplishing the test, including the initial settings for all manually controlled parameters
- Specification of testing tools/methods such as test software
- Criteria for passing or failing the test
- Specified tolerance of operation.

B.8 Hardware Qualification Test (SISO)

- A. Purpose. The QT certifies the equipment performs in its operational environment as required by the applicable specification. Successful completion of the QT constitutes delivery and acceptance of the element tested.
- B. Scope. Hardware qualification testing is conducted to verify the functional capability of an element (unit, subsystem, or system) which may consist of any combination of hardware and software components. The QT also demonstrates to the customer that the element performs to specification. Successful completion of QT and associated customer signoff constitutes acceptance by the customer. The QT (which may be a series of tests) evaluates the complete element (including interfaces) as an entity in its operational environment. The QT is normally performed at the delivery site to verify:

1. Operational Capabilities

- All internal functions perform to specification
- Required data throughput can be accomplished
- Interfaces with external equipment are operational
- Operator interface controls
- System response time meets operational requirements.

2. Onsite Workmanship. Verification is accomplished by:

- Installation inspection by QA
- Inspection of cable routing and connectors
- Verification of installation integration (equipment interface inspection, etc.).

3. External Equipment Interfaces. The following items constitute verification:

- Verification to appropriate specification
- Identification of interface tests which are being waived (and/or allocated to other system element tests).

4. System Integrity. Demonstrated by:

- Error rates within specified limits
- Verified operation during failure mode conditions
- Ability to function properly with other interfaced systems.

C. Test Procedure. The QT is conducted according to an approved qualification test procedure (QTP). The QTP provides detailed documentation of all testing required to demonstrate that the equipment is in compliance with all applicable specification requirements. The procedures will contain, as a minimum, the following:

1. Identification of system element to be tested.
2. Test objective.
3. Resources required for the test (e.g., test equipment for software test tapes, etc.).

4. Step-by-step procedure for accomplishing the test, including the initial settings for all controls, power supply voltages, etc.
5. Specification of testing tools/methods such as:
 - BITE
 - Test software (when the element has a computer interface)
6. Criteria for passing or failing the test.
7. Specified tolerance of operation.

QTP's are type 1 documentation and will be prepared in accordance with SISO Standards (Volume III, Part 5.1). The QTP is approved by the applicable SISO engineering department, Quality Assurance Department, and Program Management Office, as specified in the SISO Standards (Volume III, Part 5.4). The QTP is submitted to NASA for review at least 30 days prior to the scheduled QT.

B.9 Hardware Requalification Test (SISO)

- A. Purpose. An RT is used to verify the functional capability of a previously certified equipment item following the incorporation of a modification which expands or reduces the capacity/capability of the existing design or system. Depending on the equipment involved, the RT requirement may be satisfied by PMI's, continuity checks, tests using specialized test sets, or by an operational demonstration with associated subsystem elements. An RT may or may not require onsite computer support.
- B. Test Procedure. The writing of requalification test procedures (RTP's) is the responsibility of the SISO engineering organization that performed the system design. RTP's may, depending on test requirements, consist of a detailed test procedure, or simplified test procedure. RTP's are considered type 1 documentation, and as a minimum will be approved by the applicable SISO engineering,

Program Management Office, and Quality Assurance organizations. All RTP's will be submitted to NASA for review at least one week prior to the scheduled test. Concurrently, copies will be given to M&O for their review and familiarization prior to the scheduled test.

B.10 Test Preparation Sheet (SISO). When an equipment modification is installed which is relatively minor in nature, a test preparation sheet (TPS) may be used. SISO has the prerogative of describing the simplified tests for a minor modification required for QA and customer approval on a TPS. The TPS is a NASA form, MSC Form 1225. These forms can be used with SISO QA concurrence to cover minor testing efforts such as:

- Workmanship inspection
- Referencing M&O PMI checks which will suffice for checkout
- Simple cable or circuit continuity checks
- Simple type test procedures requiring a minimal number of steps and observations.

B.11 Software Requalification Test (SISO)

- A. Purpose. An RT is used to verify the functional capability of a computer program following the incorporation of a modification. The RT requirement may be satisfied by tests using specialized test data sets, or by an operational demonstration with associated subsystem elements.
- B. Test Procedure. The RTP is the basis for the RT. As with the QTP, it describes the goals of the tests, the resources necessary to test the changes, the detailed test procedures, the responsible organizations, and the success criteria for the test.

B.12 Onsite Acceptance Test (IBM). Onsite acceptance testing is conducted at JSC to demonstrate the capabilities of hardware elements delivered by IBM and to prove the software deliverables perform to contract specifications. The software testing demonstrates the SDPC Benchmark Program Test on each of the computer systems to be delivered.

B.13 System Integration Test (IBM). System integration testing is conducted at JSC to demonstrate the capability of the SDPC to communicate with the MCC support systems through the SDPC to MCC equipment interfaces.

B.14 Performance Test (IBM). Performance testing is conducted after system integration testing to demonstrate the operational speeds and data handling capabilities of the SDPC while interfaced to the MCC equipment in the operational configuration.

B.15 Integration Test (SISO). Integration testing is performed with each application string such as telemetry, command, trajectory, etc., to verify that the application string meets system performance requirements.

B.16 Independent Verification (IVM). Independent verification (IV) testing is an independent, requirements-oriented approach to testing in a complete system environment (all software components have been incorporated into the system). IV performs detailed software interface tests between the various applications as well as mission operations computer/dynamic standby computer interface tests, timing interference tests, final performance measurement tests, and independently defined requirements-oriented system level functional testing. Complete control of software modifications is an integral part of the IV process. The software configuration management continues into the post-delivery timeframe with detailed testing of modifications and extensive regression testing.

B.17 Operational Testing Phase. The operational testing is performed with the complete end-to-end system in an operational configuration. The testing is performed with and by users of the system utilizing tests based upon operational functions.

B.18 Reconfiguration Test (SISO). Reconfiguration testing consists of a test or a series of tests which are performed to verify a hardware/software table change. These tests are ongoing and are required prior to incorporation of the change into the operational system to verify the change and the effect of the change.

on the integrity of the MCC/Shuttle system. Examples of items which consistently require reconfiguration testing are:

- Software. Tables that define telemetry preprocessor computer telemetry downlink formats, Institutional Data Systems Division, computer-compatible tape, analog event drivers, output buffers, and SDPC output buffers, etc.
- Hardware. Analog event drivers configuration changes.

B.19 Validation Testing. Validation testing is a phase of testing to verify mission configurations. Validation test configurations are divided into three integrated hardware/software systems categories:

- MCC
- MCC/SMS
- MCC/STDN.

The tests are performed in an operational configuration to demonstrate the operational readiness of the complete system for a specified mission.

B.20 Maintenance Testing. Maintenance testing and checkout consists of a continuous testing phase to start after qualification and/or requalification of hardware/software units, subsystems or systems. Categories of maintenance testing are as follows:

- A. Preventive Maintenance Testing. Preventive maintenance testing and checkout is based on the requirement to test hardware for both electrical and mechanical performance in order to detect substandard conditions prior to failure. This testing requires special test software checkout hardware packages.
- B. Hardware Functional Unit Level Testing. Hardware unit level testing is test and checkout of a single functional unit to specification. A functional unit may be one or

more collective functions of a subsystem or a standalone unit of hardware. Testing at this level requires special software checkout hardware or hardware test equipment.

- C. Hardware Subsystem Level Testing. Hardware subsystem level testing consists of test and checkout to measure collective performance of a subsystem. Testing at this level requires special software checkout hardware or hardware test equipment.
- D. Hardware System Level Testing. Hardware system level testing consists of test and checkout to measure performance of all hardware within a system. This may be a sequence of tests using special software and/or hardware test equipment.